sidered as in reality due to a transformation or conversion of heat by its passage through an organized structure; just as heat, acting through a certain mixture of metals, manifests itself as electricity. Hence he concludes that the physical forces are as closely correlated to the vital, as those of each category are to each other; the chief distinction between their respective operations being established by the speciality of the instruments through which they manifest themselves.

13. Letter from Lieut. Gillies, U.S.N., to Lieut.-Col. Sabine, R.A., For. Sec. R.S.

U.S.N. Astronomical Expedition,
Santiago de Chile, 20th Jan. 1850.

Dear Sir,—I had the pleasure to receive your letter of Aug. 3rd by the last monthly steamer from the north, and greatly lamented I could not answer it by the mail, which left Dec. 30th. Leaving the United States on the 16th of August, want of a proper amount of fire surface in the boilers of the steam-ship, caused my arrival at Chagres only on the day (27th) when the mail for Chile left. A month was thus unavoidably lost; for in anticipation of a passage through without delay, all instruments, except an aneroid barometer and thermometer, had been despatched round Cape Horn. With these such observations were made, until arrival here, as their construction permitted. From the indications of the aneroid there is a region extending from 200 miles to the S.S.W. of San Domingo to about 1° of north latitude on this side of the continent, where the pressure rarely exceeds 29·850 in., nor was the barometer but once in that whole distance as high as 29·900 in. At Panama the mean is 29·795 in. from observations at 9 A.M., 3 P.M., and 9 P.M., with a mean diurnal fall from the first to the second hours of ·08 in. The temperature for the same hours was 81°·0 with a range of 2°·9, and almost constantly saturated with moisture, though rain fell no more frequently than often occurs during the same period in the United States. As evidence of the hygrometric condition of the atmosphere, it was found impossible to dry clothing in my room after several days' open exposure, and they were finally exposed to the direct rays of the sun. Leather moulds in forty-eight hours. The light wind experienced was almost constantly from the northward and westward during the day, and variable at night. I think Lieut.-Col. Emery made observations for declination and dip *en route* for California, but nothing is known to me of the results, and I must await our return to give you data on these points. Should nothing intervene to change present intentions, I contemplate making observations at each of the fifteen ports where the steamer touches between Valparaiso and Panama. Nothing of note occurred during our passage to Chile. There was time to glance at Buonaventura, Guyaquil, Payta, Huanchaco (part of Truxillo), Casma, five days at Lima, Pisco, Islay, Arica, Iquique, Coleiga, Copiapò and Coquimbo,—a multitude of little towns unimportant in themselves, and mentioned

only to indicate the points where I hope to obtain observations of the magnetic elements.

Reaching Santiago on the 27th of October, I was convinced in a brief time that no other part of Chile would so well answer the purposes of the expedition, and the Government here having acted promptly and with most commendable liberality on all points, there was no hesitation in selecting this city as my station. You know it is situated on a plain varying in width from twelve to forty miles, which, commencing just north of 33°, with a slight interruption in 34½°, extends to the Gulf of Onend in 41½°. The sea range of the Cordilleras, from which Santiago is distant from four to five leagues, has an elevation of 3000 to 4000 feet above the ocean, whilst the main chain to the eastward varies from 10,000 to 17,000 or 18,000 feet, and is distant about six leagues at the base. Interrupting the eastern horizon as they do, the interference with observations on the planet Venus in the morning twilight rendered so near an approach objectionable; but there was no locality in the vicinity of a proper residence free from this obstacle, and no place in the interior offering the facilities possessed by Santiago. If I mistake not, in one of my former letters I stated that the coast was impracticable, on account of very frequent fog and mist; and this was the opinion of the most observant residents here. There were two positions offered for our use by the Government,—a hill (Santa Lucia) in the eastern part of the city, with such rooms in the Castle, about half-way up, as might be needed, and the plain in the southern suburbs. The former has an elevation of some 200 feet, whilst the latter is half submerged during the rainy season, and almost inaccessible to pedestrians. Many reasons inclined me to prefer Santa Lucia, could its rocky crest be leveled, and this the Government at once undertook.

On the 9th of November, the ship having reached Valparaiso a few days after me, all the instruments *nearly*, together with the observatories, were deposited in the Castle, distant 100 miles from the ocean, having been conveyed in huge carts of the country drawn by five yokes of oxen. Chronometers, magnetical, meteorological, and all delicate instruments, were suspended by hide cords inside the carts, so as to swing free of each other, and everything came safely except three black bulb-thermometers, which Mr. Barrow had packed in sand. On opening the outer case (for the first time) the sand was found to have filtered through crevices in the packing-box, leaving the bulbs wholly unsupported. The fourth one was accidentally broken a few days after, and we are now with only one *spirit* thermometer for *radiation*, one of *them* having been, unfortunately, broken also. Our larger equatoreal was placed on its pier on the 6th of December, and on the 10th commenced the series of observations on Mars; since which time I have made more than 1100 differential measures. The superb meridian circle, made by Pistor and Martius, arrived here only at Christmas, and as it is an instrument of exceedingly limited adjustment, it has only been adjusted to the meridian a day or two. Instability of our floor rendering

additional support necessary for the joists when the extraordinary weight of the instrument is transferred to the receiving carriage, has rendered impracticable the adjustment of our microscopes thus far. But I hope to have the instrument fully at work by the 25th, stays having been driven in beneath the joists. A more exquisitely finished instrument was never turned out of a workshop.

Immediately after our location, meteorological observations were commenced, embracing eight periods of the day, at equal intervals, viz. at 3, 6, 9, 12 A.M. and P.M. Nothing is so striking to the stranger as the great dryness of the atmosphere and its almost perfect transparency, the ordinary difference of the dry and wet thermometers being above 12°, and, except over the Cordilleras to the N.E., clouds being rarely seen at this season of the year. Our barometer is of Mr. Hassler's form of construction, with a capacity above 0·6 in. Taking from the volume containing astronomical observations (no other being at hand), the meaus between 9 P.M. and meridian for the last twenty-one days of December, they are 28·126 in.; air 70°·3; wet 57°·8; and fluctuations during the same period respectively, 28·247 in. to 28·023 in.; 74°·4 to 65°·6; 61°·9 to 51°·3. From 10 A.M. till noon is the warmest period of the day; then a breeze sets in from S.W., which moderates the fierceness of the sun's rays until he sets. Our vicinity to the snow on the Cordilleras, N.E. from the city, renders night always pleasant, and indeed the temperature is never oppressive when not exposed to the direct action of the sun.

On unpacking the magnetical instruments, no top could be found for one set of the legs sent by Mr. Jones, and as it would be next to impossible to have a triangle made for securing them together, much time is unavoidably lost. One of the 3·67 in. magnets, too, is so greatly oxidized, I shall not use it until I hear from you again; and as there are no tidings of the altitude and azimuth instrument, the declinometer also must remain in its case. The hill on which the observatories have been erected being very decidedly polar, our observations for the horizontal force and dip have been made in a vineyard a few hundred yards to the eastward, and where we shall continue to make them for the present. Our own residence would have been greatly preferable; but the two portions being only about 16 feet square each, and having windows on at least two sides protected by stout bars of iron, it has been deemed objectionable. When the winter comes on it is probable a small abode house will be put up for them; at present we use them in the open air. The periods assigned for observation are, the 1st, 11th, and *term*-day of each month, commencing about 11 A.M. and ending about 4 P.M. This is all which my force will permit me to do; but if we can obtain means to mount the other tripod stand, so as to avoid loss of time in the vibration experiments, we shall have abundant leisure for the vertical and total forces as you suggest. Were the brass rings for determining the magnetic moments of the deflecting magnets measured and weighed by Mr. Jones? I have made out No. 12, outer diameter, 3·025 in.; inner, 2·338 in.; weight, 949 troy grains.

Since November 1st we have experienced five or six tremblings of the earth, principally during the first three weeks of that month. To my great mortification, the seismometer made no record either time, for this terrible visitant is of earnest interest to every one in Chile, and the object of the instrument, though greatly perverted, was a subject of much talk among the people of Santiago. The inverted pendulum has been made as sensitive as possible, and the recording pencil only pressed against the segment in the slightest manner to secure a mark—yet it has left no sign. True, the shocks were of no great violence, though strong enough to creak the ceilings overhead, and on one occasion to start every one into the street. Of the last I was warned by the rumbling noise, sufficiently long, to take out my watch and note the periods and intervals of its two shocks. To the best of our estimation the motion of the earthquake is invariably from the westward, and more frequently from W.S.W. than any other direction since November. One only of the phænomena, since our arrival, proved of serious injury; viz. that of November 18th, which kept the earth in motion in the vicinity of Coquimbo for the space of 84 seconds. Very slight injury was sustained by the houses from *this* cause; but it was immediately followed by a wave 16 feet above high-water mark, overwhelming the buildings and smelting furnaces on the shores of the bay. In Santiago I was roused from sound sleep ($6^h\ 10^m$ A.M.) by the rocking of my bed and creaking of the timbers overhead, to find all the inmates of the hotel flying to the streets. At Coquimbo shocks were repeatedly felt on the 16th, 18th, 19th and 20th, several each day. Dr. Lamont suggested an instrument to be formed of three upright cylinders wrapped with photographic paper and moved by clockwork; three beams suspended horizontally by two parallel threads each and a lamp in the centre. The subject was talked over with Prof. Henry prior to leaving the United States; and as I have since written him respecting the instrument here, it is greatly hoped one will be made after Dr. Lamont's suggestion and sent out to us.

I trust to hear from you as often as your leisure will permit, and you may feel assured your suggestions will always be gratefully received and carefully followed.

The Secretary of the Navy has authorized me to notify to all scientific correspondents, that their communications, if put under cover to "Honourable Secretary of the Navy, Washington," will be forwarded to me by the earliest monthly mail; and the Secretary of State has directed the "United States Consul, Panama," to receive and transmit free of expense any letters addressed to me. If, then, you will deposit your letters with Mr. Abbot Lawrence, they will assuredly come; or if put in the English West India mail, "care U.S. Consul, Panama," on the 1st, they will reach me on the 25th of the following month.

With my most respectful remembrances to Mrs. Sabine, believe me, dear Sir, Very faithfully yours,

S. W. Gillies.

P.S. 28th.—The most violent earthquake felt occurred on the night of the 20th, just before midnight. As usual, there were two shocks; noise with the first or preceding it, and the second most sensible; the former continuing four and the latter twelve seconds. Standing erect, the direction from which the noise and wave came was undoubtedly near W.S.W., and this position was assumed at the earliest symptom, that these facts might be more easily appreciated. Our seismometer gave no tidings.

Lieut.-Colonel Edward Sabine, R.A.,
F.R.S. &c. &c., Woolwich.

The Society then adjourned over the vacation to Thursday the 21st of November 1850.

November 21, 1850.

Dr. ROGET, V.P., in the Chair.

Dr. Graves was admitted into the Society.

The following gentlemen were elected Foreign Members:—

H. W. Dove.	J. E. Purkinje.
Joseph Liouville.	W. Weber.

November 28, 1851.

The EARL OF ROSSE, President, in the Chair.

William Fairbairn, Esq., Captain Ibbetson, and J. F. Miller, Esq., were admitted into the Society.

Dr. Faraday then delivered the Bakerian Lecture, which in substance was a résumé of the following papers:—

1. "Experimental Researches in Electricity." Twenty-fourth Series. On the possible relation of Gravity to Electricity. By Michael Faraday, Esq., D.C.L., F.R.S. &c.

Under the full persuasion that all the forces of nature are mutually dependent, and often, if not always, convertible more or less into each other, the author endeavoured to connect gravity and magnetic or electric action together by experimental results, and though the conclusions were, when cleared from all error, of a negative nature, he still thinks that the principle followed and the experiments themselves deserve to be recorded. Considering that some condition of the results produced by gravity ought to present itself, having a relation to the dual or antithetical character of the magnetic or electric forces, it seemed to the author that the approxi-